JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this Office.

Date of Application: September 26, 2003

Application Number: Patent Application No. 2003-335939

Applicant(s): Shin-Etsu Handotai Co., Ltd.

March 31, 2004

Commissioner, Japan Patent Office

[Name of Document] PATENT APPLICATION

[Reference Number] 0300201

[Address] To Commissioner of Japanese Patent Office

[International Patent Classification] H01L 21/304

[Inventor]

[Address] c/o Yokonodaira Plant, Shin-Etsu Handotai Co., Ltd., 507, Aza Matsubara, Nakanoya, Annaka-shi, Gunma-ken, Japan

[Name] Yasutsugu Soeta

[Patent Applicant]

[Identification Number] 000190149

[Name] Shin-Etsu Handotai Co., Ltd.

[Attorney]

[Identification Number] 100102532

[Patent Attorney]

[Name] Mikio Yoshimiya

[Telephone] 03-3844-4501

[Indication of Payment of Official Fee]

[Number of Prepayment] 043247

[Amount of Prepayment] 21,000 yen

[List of Submitted Paper]

[Name of Paper] Claims 1

[Name of Paper] Specification 1

[Name of Paper] Drawing 1

[Name of Paper] Abstract 1

[Number of General Power of Attorney] 9703915

[Name of Document] Claims

[Claim 1]

A polishing pad used for polishing a substrate, wherein at least grooves having a radial pattern are formed on a surface of the pad, and the number of the grooves complies with a relation of (a diameter of the substrate / the number of the grooves) is 8 or less, or (area of the substrate / the number of the grooves) is 1700 or less.

[Claim 2]

A polishing pad used for polishing a substrate, wherein at least grooves having a radial pattern are formed on a surface of the pad, and an average edge length of the grooves in parts immediately below the substrate is 6 or less when represented by (area of the substrate / the average edge length of the grooves in parts immediately below the substrate), or an average volume of the grooves in parts immediately below the substrate is 0.3 or less when represented by (a diameter of the substrate / the average volume of the grooves in parts immediately below the substrate), or is 17 or less when represented by (area of the substrate / the average volume of the grooves in parts immediately below the substrate).

[Claim 3]

A polishing pad used for polishing a substrate, wherein at least grooves having a radial pattern are formed on a surface of the pad, and the grooves are formed so that a groove depth of the groove parts located nearer to the center than the substrate is shallower than a groove depth of the groove parts existing immediately below the substrate.

[Claim 4]

The polishing pad according to any one of Claims 1 to 3, wherein the grooves are formed so that angles between the grooves are more than the values obtained by the mathematical formula 1 as follows.

(Mathematical formula 1)

An angle between the grooves = 2 x $\sin^{-1}$ (a width of the grooves / (2 x (a distance from the center of the polishing pad to the center of the substrate - a radius of the substrate))

[Claim 5]

A method for processing a polishing pad which is a method for forming grooves on a surface of a polishing pad used for polishing a substrate, comprising forming the grooves so as to have a radial pattern, and at this time forming the grooves so that the number of the grooves complies with a relation of (a diameter of the substrate / the number of the grooves) ≦ 8, or (area of the substrate / the number of the grooves) ≦ 1700.

[Claim 6]

A method for processing a polishing pad which is a method for forming grooves on a surface of a polishing pad used for polishing a substrate, comprising forming the grooves so as to have a radial pattern, and at this time forming the grooves so that an average edge length of the grooves in parts immediately below the substrate complies with a relation of (area of the substrate / the average edge length of the grooves in parts immediately below the substrate) ≦ 6, or an average volume of the grooves in parts immediately below the substrate complies with a

relation of (a diameter of the substrate / the average volume of the grooves in parts immediately below the substrate) $\leqq 0.3$, or (area of the substrate / the average volume of the grooves in parts immediately below the substrate) $\leqq 17$.

[Claim 7]

A method for processing a polishing pad which is a method for forming grooves on a surface of a polishing pad used for polishing a substrate, comprising forming the grooves so as to have a radial pattern, and at this time forming the grooves so that a groove depth of the groove parts located nearer to the center than the substrate is shallower than a groove depth of the groove parts existing immediately below the substrate.

[Claim 8]

The method for processing a polishing pad according to any one of Claims 5 to 7, wherein the grooves are formed so that angles between the grooves are more than values obtained by the mathematical formula 1 as follows.

(Mathematical formula 1)

An angle between the grooves = 2 x $\sin^{-1}$ (a width of the grooves / (2 x (a distance from the center of the polishing pad to the center of the substrate - a radius of the substrate))

[Claim 9]

A method for polishing a semiconductor substrate by using the polishing pad processed by the method according to any one of Claims 5 to 8.

[Name of Document] Specification

[Title of the Invention] POLISHING PAD AND METHOD FOR PROCESSING POLISHING PAD

[Technical Field]

[0001]

The present invention relates to a polishing pad for polishing, for example, a main surface of a semiconductor substrate, and a method for processing the polishing pad.

[Background Art]

[0002]

For a semiconductor substrate, high surface flatness is required because semiconductor devices are formed on a main surface thereof. This is because the minimum line width of wires constituting the semiconductor devices is very small, 0.2 μm or less, and therefore failures such as breaking are required to be reduced by flattening a main surface of the semiconductor substrate. This minimum line width of wires tends to be even smaller for increasing integration degree of semiconductor devices. Along with this, more improvement of surface flatness of semiconductor substrates has been required.

[0003]

For improving the surface flatness of semiconductor substrates, polishing materials for polishing the surface become important. In the case of single-side polishing such as CMP (Chemical Mechanical Polishing), as shown in Fig. 3, a semiconductor substrate 11 held by a polishing head 10 is pressed with a desired pressure onto a polishing pad 13 attached on a polishing apparatus turn table 12. The turn table 12 and the semiconductor substrate 11 rotate

by a predetermined rotation rate, and at the same time, a polishing agent (slurry) 15 is supplied from the vicinity of the center of the turn table by a nozzle 14, this polishing agent 15 gets between the semiconductor substrate 11 and the polishing pad 13 and therefore polishing proceeds.

[0004]

The polishing method is about the same at whatever size the semiconductor substrate is. However, sizes of semiconductor substrates become larger for lowering cost of semiconductor devices. In the polishing, rotations of a semiconductor substrate and a turn table are required for maintaining uniformity of polishing within the semiconductor substrate surface. However, enlargement of diameters of semiconductor substrates increases centrifugal force in the peripheral part of a semiconductor substrate by rotation of the semiconductor substrate and a distance from the peripheral part to the center of the semiconductor substrate. Therefore, a phenomenon that it becomes difficult for a polishing agent to get into the central part of the semiconductor substrate is caused. Therefore, uniform polishing is not performed within the semiconductor substrate surface, and as a result, it can cause to degrade the semiconductor substrate flatness. Accordingly, for making the polishing agent get to the central part of the semiconductor substrate so that uniform polishing can be performed within the semiconductor substrate surface, polishing pads on which grooves having various pattern shapes are formed have been invented.

[0005]

As the groove pattern shapes, there are a lattice shape (see, for example, Patent Documents 2, 3, 4 and 5), a triangular lattice shape (for example, Patent Document 4), a tortoiseshell shape, a radial shape (see, for example, Patent Documents 1 and 2), a concentric circle shape (see, for example, Patent Document 2), a combination of radial pattern grooves and concentric circular or helical grooves (see, for example, Patent Documents 3, 4 and 5), and so forth. Any one of them has been intended to enhance retention and flowability of a polishing agent and to make the polishing agent get to the central part of a semiconductor substrate, and thereby to uniform polishing amount within the semiconductor substrate surface.

[0006]

In the case of forming grooves having a lattice, tortoiseshell, or triangular lattice pattern on the polishing pad, there is some cases the grooves become parallel to the diameter direction of the turn table. However, almost all the grooves do not become parallel. If the grooves are parallel to the diameter direction of the turn table, centrifugal force by rotation of the turn table is propagated to the polishing agent as it is. Therefore, the flowability can be held to be large and the polishing agent can get through the grooves to the central part of the semiconductor substrate surface which is closely in contact with the polishing pad. However, if the grooves are not parallel to the diameter direction, the centrifugal force is divided to the groove direction and the direction orthogonal to the grooves and only the force having the groove direction acts on the polishing agent. Therefore,

flowability of the polishing agent becomes smaller. Moreover, the polishing agent getting into the grooves immediately below the substrate is divided into flows at branch points of the grooves while going to an outward direction of the turn table. Therefore, an amount of the polishing agent passing through one groove in itself becomes smaller. As the polishing agent getting through the grooves to the central part of the semiconductor substrate surface becomes less, the polishing agent getting between the polishing pad and the semiconductor substrate also becomes less. As a result, a polishing rate at the central part of the semiconductor substrate surface is smaller than a polishing rate in the peripheral part of the semiconductor substrate surface in which the polishing agent is easy to get into between the polishing pad and the semiconductor substrate from parts but grooves. Therefore, there is a case that flatness of a main surface of the semiconductor substrate can be degraded.

[0007]

On the other hand, in the case of forming concentric circular or helical grooves on the polishing pad, fine concentric circular concavity and convexity, which are called as a polishing ring, are formed on a surface of a semiconductor substrate which is polished with such a polishing pad. They are generated by transcription of concavity and convexity of the polishing pad to be formed by the grooves into a radial region because grooves of the polishing pad are always in contact with the radial region of the surface as viewed from the center of the semiconductor substrate surface. Therefore, in the case of

polishing a semiconductor substrate with a polishing pad on which concentric circular or helical grooves are formed, there is a case that surface flatness of the semiconductor substrate can be degraded. Among the polishing pads, there are ones on which radial pattern grooves and concentric circular or helical grooves are combined to be formed on the pad surface. However, as long as the concentric circular or helical grooves exist on the polishing pad, the problem of a polishing ring is inevitably caused and adversely affects flatness of the substrate surface.

[0008]

In the case of forming grooves having a radial pattern on the polishing pad, lowering of the flowability of the polishing agent by dispersion of the centrifugal force, flow division of the polishing agent at the groove parts immediately below the substrate, generation of a polishing ring are not caused. Therefore, better polishing can be expected as compared to the above-described groove shapes.

[0009]

[Patent Document 1] Japanese Patent Application Laid-open (kokai) No. 7-321076

[Patent Document 2] Japanese Patent Application Laid-open (kokai) No. 2002-100592

[Patent Document 3] Japanese Patent Application Laid-open (kokai) No. 2000-286218

[Patent Document 4] Japanese Patent Application Laid-open (kokai) No. 2000-354952

[Patent Document 5] Japanese Patent Application Laid-open (kokai) No. 2002-367937

[Disclosure of the Invention]

[The Problem to be solved by the Invention]

[0010]

Accordingly, an object of the present invention is to provide a polishing pad in which in the polishing of a semiconductor substrate and such, a required amount of a polishing agent is supplied to the central part of the substrate and thereby the polishing can be performed with high flatness, and peeling, twist or burr does not occur and a surface of a semiconductor substrate is not flawed, and a method for processing it.

[Means to solve the Problems]

[0011]

In order to accomplish the above objects, according to the present invention, there is provided a polishing pad used for polishing a substrate, wherein at least grooves having a radial pattern are formed on a surface of the pad, and the number of the grooves complies with a relation of (a diameter of the substrate / the number of the grooves) is 8 or less, or (area of the substrate / the number of the grooves) is 1700 or less (Claim 1).

[0012]

If the number of the grooves formed on the surface of the polishing pad has a relation above-described to a diameter or area of the substrate to be polished, a required amount of a polishing agent is supplied between the substrate and the polishing pad in the polishing through the grooves. Therefore, the polishing pad can be the polishing pad which a substrate having high surface flatness can be produced.

[0013]

In addition, the present invention provides a polishing pad used for polishing a substrate, wherein at least grooves having a radial pattern are formed on a surface of the pad, and an average edge length of the grooves in parts immediately below the substrate is 6 or less when represented by (area of the substrate / the average edge length of the grooves in parts immediately below the substrate), or an average volume of the grooves in parts immediately below the substrate is 0.3 or less when represented by (a diameter of the substrate / the average volume of the grooves in parts immediately below the substrate), or is 17 or less when represented by (area of the substrate / the average volume of the grooves in parts immediately below the substrate) (Claim 2).

[0014]

If the average edge length of the grooves in parts immediately below the substrate to be polished has the relation as described above to area of the substrate, or the average volume of the grooves in parts immediately below the substrate has the relation as described above to a diameter of the substrate or area of the substrate, a polishing agent supplied between the substrate and the polishing pad in the polishing through the grooves formed on the surface of the polishing pad exists immediately below the substrate with a required amount, and therefore, the polishing pad can produce a substrate having high surface flatness. Here, the edge length of the grooves in parts immediately below the substrate means the interface between the grooves existing immediately below the substrate and the polishing pad, that is, the sum of the

lengths of the groove edges. The average edge length of the grooves in parts immediately below the substrate means the averaged sum of the edge lengths changing as the polishing turn table rotates. Equally, the volume of the grooves in parts immediately below the substrate means the sum of the volumes of the grooves existing immediately below the substrate. The average volume of the grooves in parts immediately below the substrate means the averaged sum of the groove volumes changing as the polishing turn table rotates.

[0015]

Furthermore, the present invention provides a polishing pad used for polishing a substrate, wherein at least grooves having a radial pattern are formed on a surface of the pad, and the grooves are formed so that a groove depth of the groove parts located nearer to the center than the substrate is shallower than a groove depth of the groove parts existing immediately below the substrate (Claim 3).

[0016]

If the grooves are formed so that a groove depth of the groove parts located nearer to the center of the polishing pad than the substrate to be polished is shallower than a groove depth of the groove parts existing immediately below the substrate, a required amount of a polishing agent is supplied to immediately below the semiconductor substrate through the grooves in the polishing. Additionally in the grooving processing, twist of the polishing pad or peeling from the turn table which occur by a width of the polishing pad contained between the grooves near the center of the polishing pad being narrowed does not occur because the

grooves are formed so that a depth of the grooves is shallow, and therefore, generation of burr on the groove parts to be in contact with the substrate can be prevented. As a result, with the polishing pad, polishing can be carried out in a high grade state so as not to flaw a substrate surface with burr.

[0017]

In this case, it is preferable that the grooves are formed so that angles between the grooves are more than the values obtained by the mathematical formula 1 as follows (Claim 4).

(Mathematical formula 1)

An angle between the grooves = 2 x $\sin^{-1}$ (a width of the grooves / (2 x (a distance from the center of the polishing pad to the center of the substrate - a radius of the substrate)).

[0018]

If the grooves are formed so that angles between the grooves are the values obtained by the mathematical formula 1 or less, the overlapping part of the grooves is located immediately below the substrate to be polished. If the overlapping part of the grooves exists immediately below the substrate, triangular ends of the polishing pad that are contained between the radial pattern grooves also exist immediately below the substrate. In these triangular ends, peeling from the turn table, twist, or burr is easy to occur during the processing of the grooves, and if they occur, polishing flaws are caused on a substrate surface by performing polishing process. Therefore, if the polishing pad has grooves having angles more than the above-described

angles, locating the overlapping part of the grooves immediately below the substrate can be prevented, and therefore, such generation of polishing flaws can be prevented. Moreover, in the case that the angle between the grooves is more than 5°, even if the grooves are formed by a method for processing grooves by which a depth of the grooves from a peripheral part of the polishing pad to the center thereof are constant, peeling of the polishing pad from the turn table, twist, or burr does not occur in the vicinity of the center. Of course, even in such a case, as described above, a polishing pad are formed so that a groove depth of the groove parts located nearer to the center than the substrate to be polished is shallower than a groove depth of the groove parts existing immediately below the substrate.

[0019]

Moreover, the method of the present invention provides a method for processing a polishing pad which is a method for forming grooves on a surface of a polishing pad used for polishing a substrate, comprising forming the grooves so as to have a radial pattern, and at this time forming the grooves so that the number of the grooves complies with a relation of (a diameter of the substrate / the number of the grooves) ≦ 8, or (area of the substrate / the number of the grooves) ≦ 1700 (Claim 5).

[0020]

If the number of the grooves to be formed on a polishing pad surface are formed so that the number of the grooves has a relation of to a diameter or area of the substrate to be polished as described above, a required

amount of a polishing agent is supplied between the substrate and the polishing pad in the polishing through grooves. Therefore, the polishing pad which a substrate having high surface flatness can be produced can be processed.

[0021]

Accordingly, the method of the present invention provides a method for processing a polishing pad which is a method for forming grooves on a surface of a polishing pad used for polishing a substrate, comprising forming the grooves so as to have a radial pattern, and at this time forming the grooves so that an average edge length of the grooves in parts immediately below the substrate complies with a relation of (area of the substrate / the average edge length of the grooves in parts immediately below the substrate) ≦ 6, or an average volume of the grooves in parts immediately below the substrate complies with a relation of (a diameter of the substrate / the average volume of the grooves in parts immediately below the substrate) ≦ 0.3, or (area of the substrate / the average volume of the grooves in parts immediately below the substrate) ≦ 17 (Claim 6).

[0022]

If the grooves to be formed on a surface of the polishing pad are formed so that the volume of the grooves in parts immediately below the substrate to be polished has a relation as described above to an area of the substrate, a polishing agent supplied between the substrate and the polishing pad in the polishing through the grooves exists immediately below the substrate with a required amount, and

therefore the polishing pad which the substrate having a high accuracy of the surface flatness can be produced can be processed.

[0023]

Furthermore, the method of the present invention provides a method for processing a polishing pad which is a method for forming grooves on a surface of a polishing pad used for polishing a substrate, comprising forming the grooves so as to have a radial pattern, and at this time forming the grooves so that a groove depth of the groove parts located nearer to the center than the substrate is shallower than a groove depth of the groove parts existing immediately below the substrate (Claim 7).

[0024]

If the grooves are formed so that a groove depth of the groove parts located nearer to the central side of the polishing pad than a substrate to be polished is shallower than a groove depth of the groove parts existing immediately below the substrate, a required amount of a polishing agent is supplied to immediately below the substrate in the polishing. Additionally in forming and processing the grooves, twist of the polishing pad or peeling from the turn table which is caused by a width of the polishing pad contained between the grooves in the vicinity of the center of the polishing pad being narrowed is prevented by forming the grooves so that a depth of the grooves is shallow, and therefore, generation of burr in groove parts which is in contact with the substrate can be prevented. As a result, a polishing pad by which polishing can be carried out in a high grade state so as not to flaw

a substrate surface with burr can be processed.

[0025]

In this case, it is preferable that the grooves are formed so that angles between the grooves are more than values obtained by the mathematical formula 1 as follows (Claim 8).

(Mathematical formula 1)

An angle between the grooves = 2 x $\sin^{-1}$ (a width of the grooves / (2 x (a distance from the center of the polishing pad to the center of the substrate - a radius of the substrate))

[0026]

If the grooves are formed at angles of the values obtained by the mathematical formula 1 or less, the overlapping part of the grooves exists immediately below the substrate. If the overlapping part of the grooves exists immediately below the substrate, triangular ends of the polishing pad that are contained between the radial pattern grooves also exist immediately below the substrate. In these triangular ends, peeling from the turn table, twist, or burr tends to occur in the processing of the grooves, and if they occur, polishing flaws are generated on the substrate surface by performing the polishing process. Accordingly, if the grooves are formed so as to have angles more than the above-described angles, the overlapping part of the grooves is not located immediately below the substrate, and therefore, a polishing pad by which such polishing flaws are not generated can be processed. In addition, if the angle between the grooves is more than 5°, even if the grooves are formed by a method

for processing grooves by which a depth of the grooves from a peripheral part of the polishing pad to the center thereof are constant, peeling of the polishing pad from the turn table, twist, or burr does not occur in the vicinity of the center. Of course, even in such a case, as described above, a polishing pad is formed so that a groove depth of the groove parts located nearer to the center than the substrate to be polished is shallower than a groove depth of the groove parts existing immediately below the substrate.

[0027]

Moreover, the present invention provides a method for polishing a semiconductor substrate by using the polishing pad processed by any one of the above described methods (Claim 9).

If the semiconductor substrate is polished by using the polishing pad processed by the above described methods, the substrate with the high flatness can be obtained.

[Effects]

[0028]

According to the polishing pad of the present invention, grooves are formed on a surface of the polishing pad so that relations of a diameter or a volume of a semiconductor substrate to be polished and the number of grooves, a diameter or an area of a semiconductor substrate and a volume of the grooves, or a diameter of a substrate and an edge length of the grooves comply with the predetermined relation. Thus, if a semiconductor substrate is polished by using the above mentioned polishing pad, a semiconductor substrate with a high surface flatness can be obtained.

Moreover, grooves in the vicinity of the center of the polishing pad are formed shallowly, and thereby the occurrence of peeling and twist in the vicinity of the center of the polishing pad can be prevented. The burr which occurs on the surface of the polishing pad caused by the occurrence of peeling and twist can be prevented, and consequently it can be prevented to flaw the surface of the semiconductor substrate with burr.

[Best Mode for Carrying out the Invention]

[0029]

Hereinafter, embodiments of the present invention will be explained by exemplifying a case of polishing a semiconductor substrate as a substrate. However, the present invention is not limited thereto.

[0030]

As described above, in the case of forming radial pattern grooves on a polishing pad, lowering of flowability of a polishing agent due to dispersion of centrifugal force, or flow division of the polishing agent in groove parts immediately below the substrate and generation of a polishing ring are not caused, and therefore, better polishing can be expected as compared to the other groove shapes such as a lattice shape or a concentric circle shape. However, in the polishing pad on which radial pattern grooves are formed, there is a problem as follows.

[0031]

In general, radial pattern grooves are formed on a polishing pad with making angles between the grooves constant. In the case that such a polishing pad having radial pattern grooves as described above is attached to a

turn table of an one-side polishing apparatus like a CMP apparatus and a semiconductor substrate is polished, the semiconductor substrate is held by a retainer ring of a polishing head being in a certain distance from the center of the polishing pad, thereby a distance between the center of the semiconductor substrate and the center of the polishing pad becomes constant. Therefore, if diameters of semiconductor substrates are various, the numbers of the grooves existing immediately below the substrates are also various and amounts of a polishing agent supplied between the substrates and the polishing pads through the grooves result in differences. Therefore, even if polishing is performed with the same polishing apparatus, with the same polishing pad, and on the same polishing condition, in the case that diameters of semiconductor substrates to be polished are various, final flatness of the surface of the semiconductor substrates occasionally can result in differences.

[0032]

On the other hand, in general, for forming radial pattern grooves, a polishing pad is subjected to grooving process with a grooving machine tool. In this case, if the number of the grooves becomes larger, a width of the polishing pad existing between the grooves in the vicinity of the center of the polishing pad is more narrowed, and therefore, the polishing pad peels from the turn table or twists in the grooving process and accurate grooving becomes impossible and at the same time burr can be generated on the edges of the formed grooves. If this burr gets in touch with the semiconductor substrate surface in

the polishing, flaws are generated on the substrate surface and which can adversely affect the quality of the semiconductor substrate significantly.

[0033]

Therefore, for example, in the Patent Document 2, there has been disclosed a polishing pad having radial pattern grooves which is produced by attaching fan-like pieces of a polishing pad to a surface of a turn table. Certainly, it is not necessary to form grooves on the polishing pad in this method, and peeling, twist, and burr are not generated. However, the surface height of each piece of the polishing pad must be uniformed and for forming grooves having constant widths, accuracy is also required for attaching it to a turn table. Therefore, in practice, it is difficult to perform the polishing so that flatness of the surface of a semiconductor substrate becomes high.

[0034]

The present inventor has carried out experiments by forming radial pattern grooves on a polishing pad, and polishing semiconductor substrates having various diameters. And he has found that there is a particular relation between the number of the radial pattern grooves, and diameters or areas of the semiconductor substrate, or volumes of the grooves and areas of the semiconductor substrate, and have accomplished the present invention. Moreover, experiments for forming grooves on the polishing pad on various conditions have been performed and a grooving method, in which in forming the grooves, twist of the polishing pad and peeling from a turn table do not occur even if a width of the polishing pad contained

between the grooves in the vicinity of the center of the turn table are small, and the present invention has been accomplished.

[0035]

Hereinafter, embodiments of the present invention will be explained in detail with reference to drawings. However, the present invention is not limited to these.

Fig. 1 shows a schematic view for explaining a method for processing a polishing pad according to the present invention.

First, before the processing, with regard to a predetermined semiconductor substrate, the number of the grooves complying with a relation of a value in which a diameter of a semiconductor substrate is divided by the number of grooves to be formed on the polishing pad is 8 or less, or an area of a semiconductor substrate is divided by the number of grooves to be formed on the polishing pad is 1700 or less are calculated. In addition, a groove width and a groove depth which comply with a relation of a value in which the area of the semiconductor substrate is divided by the average length of the edges in groove parts immediately below is 6 or less is calculated from the locations of the substrate and the grooves, or a groove width and a groove depth which comply with a relation of a value in which a diameter of the substrate is divided by the average volume of the groove parts immediately below the substrate is 0.3 or less, or a value in which an area of the substrate is divided by an average volume of the grooves in parts immediately below the substrate is 17 or less are calculated from the groove width and the groove

depth, and from a diameter of the substrate and the area of the substrate. Furthermore, an angle between the grooves with which overlapping part of the grooves does not get into immediately below the substrate is calculated from the substrate radius, the distance from the center of the polishing pad to the center of the substrate, and the groove widths. As described above, the grooves to be formed is determined to have the number of the grooves and groove volumes complying with the above-described relation and to have an angle between grooves which is the calculated angle or more.

In addition, the material of the polishing pad of the present invention may be what is generally used for polishing a substrate of silicon or the like, and for example, expandable polyurethane can be used independently of the foam density, the foam size, or the like, and polyurethane of a suede type or a polyester nonwoven cloth can also be used.

[0036]

Next, a polishing pad is fixed to a conventional grooving apparatus and the polishing pad is grooving-processed by using grooving jigs. One example of the specific processing procedure will be explained with reference to Fig. 1. C represents the polishing pad center and A represents the polishing pad surface before the grooving, respectively. First, a tip end of the jig is brought into contact with the polishing pad surface A and the height is defined as the original point. Next, after the jig is once moved to a location of the peripheral side of the polishing pad in which the polishing pad does not

exist, the tip end of the grooving jig is lowered to the height of B which is a desired groove depth. Then, the grooving is performed by making the grooving jig cut into the polishing pad periphery to the polishing pad center. The surface of B formed at this time corresponds to the groove bottom, and which is formed with a constant depth at first. The grooving process with a constant depth is performed from the polishing pad periphery to at least the groove parts which get into immediately below a substrate in the substrate polishing, namely, to the location of the substrate edge in the central side of the polishing pad, and the grooves nearer to the center than that are processed so as to have a shallower groove depth. As a method for forming shallow grooves in this case, firstly the outer grooves of the groove parts which get into immediately below a substrate are formed, and after that, the grooves nearer to the center than that are formed so that two-tiered stair-like grooves may be formed; or alternatively, the outer grooves of the groove parts which get into immediately below a substrate is formed, and the processing is continued with shallowing the groove depth as it is. After obtaining a desired groove depth, the grooves may be formed to the center of the polishing pad with the constant groove depth. In the example as shown in Fig. 1, after forming the outer grooves of the groove parts which get into immediately below a substrate, the grooving process is continued toward the polishing pad center with shallowing the groove depth. When the groove depth becomes D, feeding of the grooving jig in the upward direction is halted, and then, the grooves having a constant depth are

formed to the center of the polishing pad. The surface of D represents the bottom face of the shallow grooves formed in the central side of the polishing pad. In addition, the groove shape may be any shape as long as a required amount of a polishing agent can be flowed to immediately below a substrate in polishing. For example, V-shape grooves with V-shape bottoms, or U-shape grooves with U-shape bottoms is possible. With regard to a groove depth, at least, about 0.5-2 mm is preferable for the groove parts from the polishing pad periphery to the substrate edge in the central side of the polishing pad, and as to the groove parts nearer to the center than that, about 0.5 mm or less is preferable in the case of forming shallow grooves.

[0037]

In addition, if the angles between the grooves are more than 5°, neither peeling nor generation of burr along with grooving is caused in the polishing pad existing between the grooves, and therefore, the grooving process can be performed so that the depth of a groove to be formed is constant from the polishing pad periphery to the center thereof and that only the relations of the number of the grooves and a diameter of the substrate, or the number of the grooves and an area of the substrate are noted. Of course, as described above, the processing may be performed at a predetermined groove depth from the polishing pad periphery to the location of the substrate edge in the central side of the polishing pad and the processing may be performed at a shallower groove depth nearer to the center than that.

[0038]

After the formation of the first groove as described above, the polishing pad is rotated at a determined angle between the grooves and the second groove is formed in the same manner. By repeating this operation, grooves having a desired shape in desired numbers are formed on the polishing pad. The polishing pad processed as described above is shown in Fig. 2. This polishing pad 20 is formed so that the number of the groove 21 complies with a relation of (a diameter of the substrate / the number of the grooves) $\leqq$ 8, (area of the substrate / the number of the grooves) $\leqq$ 1700, or (area of the substrate / the average edge length of the grooves in parts immediately below the substrate) $\leqq$ 6, (a diameter of the substrate / the average volume of the grooves in parts immediately below the substrate) $\leqq$ 0.3, or (area of the substrate / the average volume of the grooves in parts immediately below the substrate) $\leqq$ 17. In addition, the grooves 21 has a predetermined groove depth from the polishing pad periphery to the location of the substrate edge in the central side of the polishing pad and has a shallower groove depth nearer to the center than that. Therefore, the polishing pad is attached to a turn table of a polishing apparatus and a substrate is polished, and thereby a semiconductor substrate with a high accuracy of the surface flatness without a flaw can be produced.

As described above, it is sufficiently effective that the relations of (a diameter of the substrate / the number of the grooves), (area of the substrate / the number of the grooves), (area of the substrate / the average volume of the grooves in parts immediately below the substrate) or

the like, and the relation of the groove depths in the present invention are satisfied respectively. However, if they are satisfied at the same time, a substrate can be polished to achieve better flatness.

[Examples]

[0039]

Hereinafter, Examples according to the present invention and Comparative Examples will be explained in detail. However, the present invention is not limited thereto.

(Example 1)

Grooves were formed on a polishing pad made of polyurethane by the method of the present invention as follows: The distance between the center of the polishing pad and the center of a substrate to be polished was 200 mm. The substrate to be polished was a silicon wafer having a 300-mm diameter. The groove shape was V-shape groove. The groove depth from the polishing pad periphery to the location of the substrate edge in the central side of the polishing pad was 1.5 mm. The groove depth of the parts having a constant groove depth from the location of the substrate edge in the central side of the polishing pad to the center of the polishing pad was 0.5 mm. The groove widths were 2.0 mm. In this case, if the angles between the grooves were 2.29° or less, the parts where grooves overlap each other got into immediately below the wafer. Therefore, the angles between the grooves were 4° and the number of the grooves was 90. The value that a diameter of the semiconductor substrate was divided by the number of the formed grooves was 3.33. The value that an area of the

semiconductor substrate was divided by the number of the formed grooves was 785.4. Additionally, the value that the area of the semiconductor substrate was divided by the average volume of the groove parts immediately below the substrate was 8.52. Such a polishing pad as described above was attached to a turn table of a polishing apparatus and the silicon substrate having a 300-mm diameter was polished. As a result, the average flatness was 4.21 nm. Moreover, there was no generation of flaws and such on the polished surface of the substrate.

[0040]

(Example 2)

Grooves were formed on a polyurethane polishing pad so that the distance between the center of the polishing pad and the center of a substrate to be polished was 200 mm, the angles between the grooves were 12°, the groove shape was U-shape groove, the groove widths were 2.0 mm and the number of the grooves was 30. In this polishing pad, the angles between the grooves were large and therefore the groove depth from the location of the peripheral edge of the polishing pad to the center of the polishing pad was constant, 1.5 mm. In the case that the substrate to be polished was a silicon wafer having a 200-mm diameter, the value that a diameter of the semiconductor substrate was divided by the number of the formed grooves was 6.67 and the value that an area of the semiconductor substrate was divided by the number of the formed grooves was 1047.2. Moreover, the value that the area of the semiconductor substrate was divided by the average volume of the groove parts immediately below the substrate was 15.73. Such a

polishing pad as described above was attached to a turn table of a polishing apparatus and the silicon substrate having a 200-mm diameter was polished. As a result, the average flatness was 4.87 nm.

[0041]

(Comparative Example 1)

Grooves were formed on a polyurethane polishing pad so that the distance between the center of the polishing pad and the center of a substrate to be polished was 200 mm, the angles between the grooves were 15°, the groove shape was U-shape groove, the groove widths were 2.0 mm and the number of the grooves was 24. In this polishing pad, the angles between the grooves were large and therefore the groove depth from the location of the peripheral edge of the polishing pad to the center of the polishing pad was constant, 1.5 mm. In the case that the substrate to be polished was a silicon wafer having a 300-mm diameter, the value that a diameter of the semiconductor substrate was divided by the number of the formed grooves was 12.5 and the value that an area of the semiconductor substrate was divided by the number of the formed grooves was 2943.8. Moreover, the value that the area of the semiconductor substrate was divided by the average volume of the groove parts immediately below the substrate was 24.65. Such a polishing pad as described above was attached to a turn table of a polishing apparatus and the silicon substrate having a 300-mm diameter was polished. As a result, the average flatness was 6.00 nm.

[0042]

The present invention is not limited to the embodiments

described above. The above-described embodiments are merely examples, and those having the substantially same constitution as that described in the appended claims and providing the similar working effects are included in the scope of the present invention.

For example, with regard to a diameter of a semiconductor substrate, although ones having a 200-mm diameter and a 300-mm diameter were exemplified, the diameter may be the same or more or less than that.

Moreover, the number of the grooves to be formed in a radial pattern on a polishing pad, that is, the angles between the grooves may be calculated from a relation between a value that a diameter of the substrate and the area of the substrate are divided by the average area of the grooves immediately below the substrate, and the average flatness.

Furthermore, although for explanation a semiconductor was exemplified as a substrate to be polished, the present invention is not limited thereto, but it can produce a polishing pad which can be applicable to polishing a delicate substrate which requires flatness such as quartz and oxide single crystal.

[Industrial Applicability]

[0043]

The present invention can be used for a polishing pad used for polishing substrates including a silicon wafer, and a step for grooving.

[Brief Explanation of the Drawings]

[0044]

[FIG. 1] It is a schematic view for explaining a

method for processing a polishing pad according to the present invention.

[FIG. 2] It is a schematic view of a polishing pad according to the present invention.

[FIG. 3] It is a schematic view of polishing a semiconductor substrate with a conventional polishing pad.

[Explanations of Letters and Numerals]

[0045]

10 ... Polishing Head, 11 ... Semiconductor Substrate,

12 ... Polishing Apparatus Turn Table, 13 ... Polishing Pad,

14 ... Nozzle, 15 ... Polishing Agent,

20 ... Polishing Pad, 21 ... Grooves,

A ... Location of the Polishing Pad Surface before the Grooving,

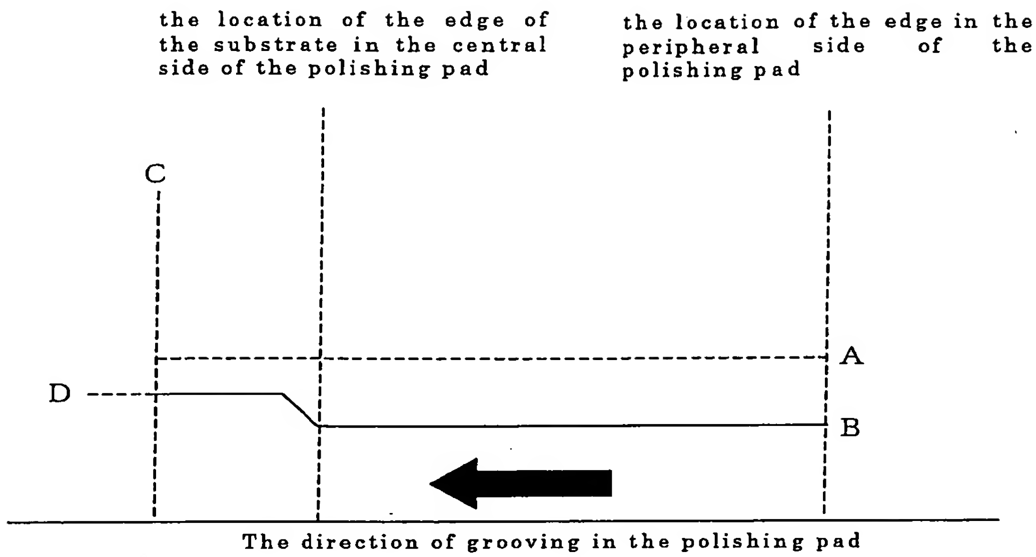
B ... Location of the Bottom Face of the Grooves From the Location of the Edge of the Substrate in the Central Side of the Polishing Pad to the Location of the Edge in the Peripheral Side of the Polishing Pad,

C ... Location of the Polishing Pad Center,

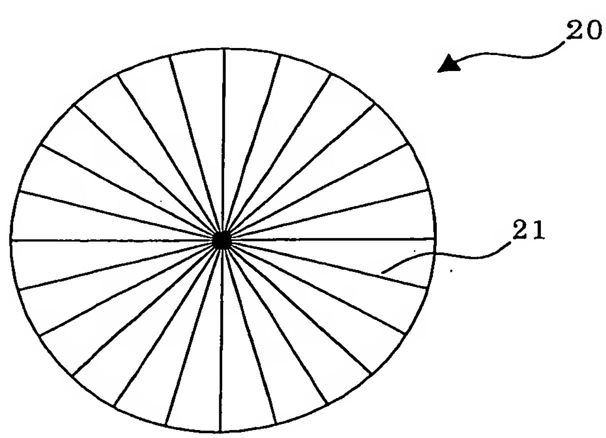
D ... Location of the Bottom Face of Grooves in the Groove Parts with the Constant Groove Depth among the Grooves from the Edge of the Substrate in the Central Side of the Polishing Pad to the Polishing Pad Center.

[Name of Document] Drawings

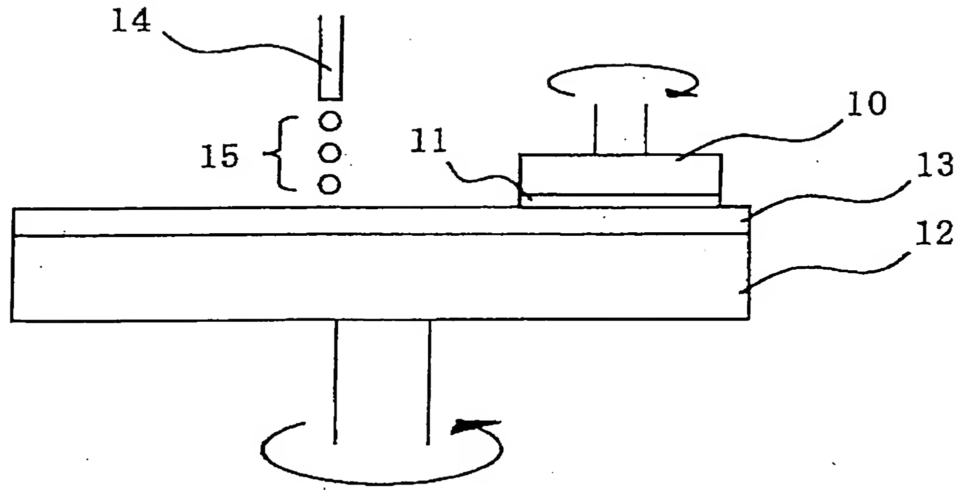
[FIG. 1]



[FIG. 2]



[FIG. 3]



[Name of Document] Abstract

[Abstract]

[Object] There can be provided a polishing pad, by which in the polishing of a semiconductor substrate, a required amount of a polishing agent is supplied to the central part of the substrate and thereby polishing can be performed with high flatness and furthermore the semiconductor substrate surface is not flawed because peeling, twist, or burr does not occur and a method for processing it.

[Means to solve the Problem] A polishing pad used for polishing a semiconductor substrate, wherein, at least, grooves having a radial pattern are formed on a surface of the pad. In regard to the grooves, (a diameter of the substrate / the number of the grooves) is 8 or less, (area of the substrate / the number of the grooves) is 1700 or less, (area of the substrate / the average edge length of the grooves in parts immediately below the substrate) is 6 or less, (a diameter of the substrate / the average volume of the grooves in parts immediately below the substrate) is 0.3 or less, or (area of the substrate / the average volume of the grooves in parts immediately below the substrate) is 17 or less. Moreover, the grooves are formed so that a groove depth of the groove parts located nearer to the center than the substrate is shallower than a groove depth of the groove parts existing immediately below the substrate, and a method for processing it.

[Selected Figure(s)] None